

A Subsurface Explorer for Deep Underground Exploration on Mars.

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Abstract: A subsurface explorer (SSX) is being developed at the Jet Propulsion Laboratory, which is suitable for exploration of the deep underground environments on Mars. The device is a self-contained piledriver, which uses a novel "spinning hammer" technology to convert a small continuous power feed from the surface over a two-wire tether into a large rotational energy of a spinning mass. The rotational energy is converted to translational energy by a novel mechanism described here. The hammer blows propagate as shock waves through a nosepiece, pulverizing the medium ahead of the SSX. A small portion of the pulverized medium is returned to the surface through a hole liner extending behind the SSX. This tube is "cast in place" from two chemical feedstocks which come down from the surface through passages in the hole liner and which are reacted together to produce new material with which to produce the hole liner. The lined hole does not need to be the full diameter of the SSX: approximately 100 kilograms of liner material can create a tunnel liner with a 3 mm inside diameter and a 6 mm outside diameter with a total length of 4 km. Thus it is expected that core samples representing an overlapping set of 3-mm diameter cores extending the entire length of the SSX traverse could be returned to the surface. A pneumatic prototype has been built which penetrated easily to the bottom of an 8 meter vertical test facility. An electric prototype is now under construction. It is expected that the SSX will be able to penetrate through sand or mixed regolith, ice, permafrost, or solid rock, such as basalt. For pure or nearly pure ice applications, the device may be augmented with hot water jets to melt the ice and stir any sediment, which may build up ahead of the vehicle. It is expected that an SSX approximately 1 meter long, 3-4 cm in diameter, and with a power budget of approximately 200 Watts will be able to explore up to ~5 kilometers deep at the rate of about 10 meters per day.